PLANT ITEM MATERIAL SELECTION DATA SHEET

R10591498

ISSUED BY
RPP-WTP PDC

PVP-SCB-00002 (PTF)
Vessel Vent Caustic Scrubber

- Design Temperature (°F)(max/min): 150/-20
- Design Pressure (psig) (max/min): 15/-5
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on sheets 5 and 6

Equipment will not be maintained.

Options Considered:

- Normal operating conditions
- Demineralized water or acid wash

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X (column)	
6% Mo (N08367)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1	X	

Recommended Material: Column: 316 (max 0.030% C; dual certified)
(0.040 inch corrosion allowance includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)
Column packing: UNS N08367 (0.0 inch corrosion allowance)
Demister packing: UNS N08367 (0.0 inch corrosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water

11/17/05

EXPIRES: 12/07/07

Please note that source, special nuclear and byproduct materials, as defined in the Atomic Energy Act of 1954 (AEA), are regulated at the U.S. Department of Energy (DOE) facilities exclusively by DOE acting pursuant to its AEA authority. DOE asserts, that pursuant to the AEA, it has sole and exclusive responsibility and authority to regulate source, special nuclear, and byproduct materials at DOE-owned nuclear facilities. Information contained herein on radionuclides is provided for process description purposes only.

This bound document contains a total of 6 sheets.

REV	DATE	REASON FOR REVISION	PREPARER	CHECKER	APPROVER
1	11/17/05	Issued for Permitting Use			
0	11/2/04	Issued for Permitting Use	DLA	JRD	APR

PLANT ITEM MATERIAL SELECTION DATA SHEET

Corrosion Considerations:

The scrubber treats the vent off-gas stream collected from the process vessels in the Pretreatment facility. Part of the NO_X/acid gases present in the stream reacts with the caustic in the scrubber to form sodium nitrate. Fresh 5M caustic solution is added to control the pH of the recirculating scrubbing liquid. It is expected that dilute nitric acid will probably be used to dissolve solids build-up in the column.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series stainless steels are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect. In this system, the normal hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable.

Dilute acid is not expected to be a concern even in dissolving deposits.

The corrosion rate of the 6% Mo alloys is expected to be the same or less than that of the 300 serious stainless steels.

Conclusion:
At the stated temperatures, 304L, 316L or a 6% Mo are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy and during normal operation < 0.1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Under the stated conditions, 316 stainless steel or better will be required. If the system is always operating, 316L will be satisfactory. However if extended periods of stagnation are likely, a more resistant alloy will be needed. 6% Mo alloys are more resistant to pitting than 316L.

Conclusion:
316L is recommended for the main vessel. 6% Mo is also acceptable.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not applicable.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. It is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as 10 ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 104°F and 304L is expected to be satisfactory. Because of the possibility of chloride concentration, 316L would be the minimum choice.

Conclusion:
At the normal operating environment, the minimum alloy recommended for normal operation is a 316L stainless although a 6% Mo is acceptable.

e Crevice Corrosion
Crevice corrosion occurs at lower temperatures than does pitting. The presence of packing in contact with itself and the wall of the vessel can lead to crevice attack. The demister pad is at risk where strands contact one another. AL6XN is more resistant than 316L.

Conclusion:
316L is satisfactory for vessel if crevices are minimized. Packing should be AL_2O_3 or 316L or better. Demister pads should be 6% Mo.

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system under normal operating conditions.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are generally not ideal for MIC.

Conclusion:
MIC is not considered a problem.

PLANT ITEM MATERIAL SELECTION DATA SHEET

h Fatigue/Corrosion Fatigue
Corrosion fatigue does not appear to be a concern.

Conclusions
Not a expected to be a concern.

i Vapor Phase Corrosion
Vapor phase corrosion will be a function of the degree of agitation, solution chemistry, and temperature. Nonetheless, it is not deemed a problem in this vessel.

Conclusion:
Not likely to be a concern.

j Erosion
Velocities are expected to be low. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expected to be a concern.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No significantly dissimilar metals are present.

Conclusion:
Not expected to be a concern.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid.

PLANT ITEM MATERIAL SELECTION DATA SHEET

References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
5. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
6. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218
7. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
8. Wilding, MW and BE Paige, 1976, *Survey on Corrosion of Metals and Alloys in Solutions Containing Nitric Acid*, ICP-1107, Idaho National Engineering Laboratory, Idaho Falls, ID

Bibliography:

1. CCN 130171,Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. Agarwal, DC, *Nickel and Nickel Alloys*, In: Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
3. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
4. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141
5. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158
6. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Vessel vent caustic scrubber (PVP-SCB-00002)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	4.23E-02	4.19E-02			
Chloride	g/l	1.73E-02	2.00E-02			
Fluoride	g/l	2.01E-02	2.34E-02			
Iron	g/l	3.17E-03	3.46E-03			
Nitrate	g/l	1.47E-01	1.66E-01			
Nitrite	g/l	4.40E-02	5.08E-02			
Phosphate	g/l	6.63E-02	7.51E-02			
Sulfate	g/l	3.54E-02	4.08E-02			
Mercury	g/l					
Carbonate	g/l					
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note 3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-PVP-00001, Rev A
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: PVP04
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0021001, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1×10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T operation 24590-PTF-MVC-PVP-00012, Rev A
3. pH approximately 7

Assumptions:

PLANT ITEM MATERIAL SELECTION DATA SHEET

4.8.3 Vessel Vent Caustic Scrubber (PVP-SCB-00002)

Routine Operations

The vessel vent caustic scrubber treats the vent offgas stream collected from the process vessels in the PT facility, primarily absorbs the NO_x/acid gases and removes large particulates from the gases. The vessel vent caustic scrubber also removes radioactive aerosols and reduces radioactive particulate loading on the vessel vent HEMEs located downstream of the caustic scrubber. The vent offgases flow upwards in the scrubber through a packed bed filled with Raschig rings or similar packing, and contact with alkaline scrubbing liquid flowing downward in the packed bed. Chilled water is circulated in a cooling jacket that surrounds the lower "sump" portion of the vessel to remove heat generated from the reactions of NO_x and other gases with the caustic present in the scrubbing liquid. The outlet gases from the scrubber flow to the vessel vent HEMEs.

Part of the NO_x/acid gases in the vent gas stream reacts with the caustic in the scrubbing liquid to form sodium nitrate. The scrubbing liquid solution is collected in the sump portion of the vessel below the packed bed section of the scrubber. Recirculating pumps recirculate scrubbing liquid solution to the top of the packed bed section of the scrubber and part of the solution directly to the sump portion to provide adequate mixing. Fresh 5 M caustic solution supplied by the metering pump from the sodium hydroxide reagent system is added to the scrubber sump vessel to control the pH of the recirculating scrubbing liquid.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.